TECHNICAL MANUAL

OPERATION AND MAINTENANCE INSTRUCTIONS

STORAGE TANK, LIQUID OXYGEN
TYPE TMU-7A/E
2,000 GALLON CAPACITY
PART NO. C70013
NSN 3655-01-245-8408YD

HYDRA-RIG CRYOGENICS, INC.
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FOREWORD

Purpose. This technical manual will provide the using activity with operation and service instructions for the Liquid Oxygen Storage and Transfer Tank, Type TMU-7A/E.

Scope. This manual will provide the using activity with applicable information required on the handling, storage, and hazards associated with the use of cryogenic equipment and products. Any corrections regarding this technical manual should be submitted in accordance with TO 00-5-1.

Throughout this manual the unit will primarily be called the Tank. It may also be called the Storage Tank. Tanks referenced but not covered by this manual will contain additional descriptions. Example: supply tank and receiving tank. Liquid oxygen may be referred to as the product, or abbreviated as LOX in parts of this manual.

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SAFETY SUMMARY

The following are general safety precautions which are related to liquid oxygen equipment. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance while using this equipment. Specific precautions will be included in the text for certain potentially hazardous operations in the form of a WARNING or CAUTION statement. The following information appears in the text of this publication and is presented here for emphasis.

QUALIFIED PERSONNEL

Only qualified personnel shall be authorized to operate and perform maintenance on this equipment.

PROTECTIVE EQUIPMENT

Personnel operating and performing maintenance on this equipment shall wear protective clothing and equipment as directed in TO 00-25-172.

BODILY CONTACT

Never allow liquid oxygen or the piping on the equipment to contact the skin. The extremely low temperatures created by liquid oxygen will immediately freeze the body area and result in severe frostbite.

EMERGENCY TREATMENT OF BODILY CONTACT

In the event of bodily contact with liquid oxygen or the Tank piping remove the victum from the exposure immediately. Do not attempt to rewarm any bodily part as this should be accomplished by proper medical personnel. Transport the patient to an emergency room of a hospital or clinic as soon as possible. Keep the patient dry and warm enroute to the emergency room. Upon arrival identify the injury as exposure to liquid oxygen.

UNAUTHORIZED CONTAINERS

Never put liquid oxygen in any container without proper safety devices (e.g. thermos bottle). When heated liquid oxygen will expand rapidly and build pressures to extremely high levels. The results of pressure buildup without safety devices may result in an explosion.

KEEP AWAY FROM ABSORBENT MATERIALS

Liquid oxygen must be kept away from absorbent materials such as rags, wood, paper, and clothing. These materials may trap the oxygen gas and later be ignited by any source of spark or flame.

SAFETY SUMMARY—CONTINUED

KEEP AWAY FROM HYDROCARBONS

Liquid oxygen is not compatible with hydrocarbons. Forms of hydrocarbons are oils, greases, gasoline, tar, and asphalt. Liquid oxygen in contact with hydrocarbons present a severe explosive hazard. The equipment, its components, and tools used in maintenance must be kept free of hydrocarbons.

SMOKING

Do not smoke or permit smoking within fifty (50) feet of Tanks in liquid oxygen service. Do not carry sources of flame in the vicinity of Tanks in liquid oxygen service. Use caution in smoking immediately after being exposed to liquid oxygen vapors as these vapors may be still trapped in clothing.

VENTILATION

Adequate ventilation must be provided for personnel for Tank functions such as transfer operations, filling, draining, purging, painting, welding, brazing, and cleaning.

LIFTING

Equipment used in lifting and moving the Tank must be of sufficient rating to handle the weights involved.

PART CLEANNESS

All parts used in liquid oxygen service must be kept clean and free of hydrocarbons. Never use shop air to dry cleaned parts. Ultraviolet lights are used to check parts that have been cleaned. Overexposure to ultraviolet light can result in conjunctivitis (inflammation of the inner eyelid and eyeball) and possible skin burns which could result in skin cancer.

PURGING

When purging a Tank all piping and valves become hot enought to burn. Ensure Tank components are at ambient temperatures before attempting handling or removal after purging operations.

SAFETY SUMMARY—CONTINUED

WELDING AND BRAZING

Welding or brazing operations produce heat, metal fumes, injurious radiation, metal slag, and airborne particles. Proper equipment must be worn before welding or brazing. Never look directly at the arc when welding or the flame during brazing. Never attempt welding or brazing operation near Teflon components (e.g. anti-seize tape). Teflon components deteriorate at high temperatures and emit poisonous gases. Proper ventilation is a must when welding or brazing.

TANK VACUUM

Never break the vacuum in the annular space with liquid product in the Tank. The liquid product must be drained.

PAINTING

Paint and coatings may affect skin, eyes, and respiratory functions. Proper ventilation is a must and avoid repeated contact when possible.

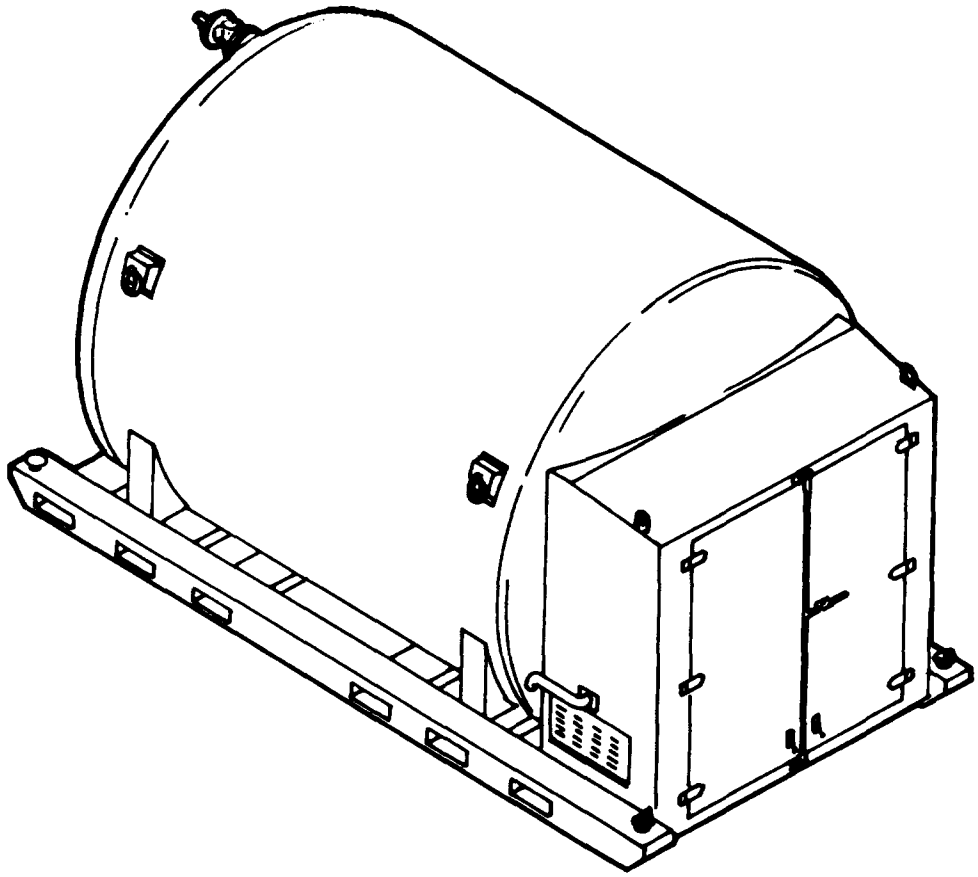


Figure 1-1. Tank, Storage, Liquid Oxygen, Type TMU-7A/E.

SECTION I
INTRODUCTION AND GENERAL INFORMATION

1-1 INTRODUCTION.

1-1.1 Purpose. This manual will provide the using command with operation and maintenance instructions. These instructions are for a Storage Tank, Liquid Oxygen, Type TMU-7A/E. It has a storage capacity of 2000 gallons. The Tank is built by Hydra Rig Cryogenics, Inc., Schulenburg, Texas under part number C70013 (See Figure 1-1).

1-1.2 Scope. This manual will provide information required for filling, storage, and transfer of liquid oxygen. In addition instructions are included to allow maintenance activities to effect repairs using common tools.

1-1.3 Arrangement. Arrangement of this manual is in sections. Each section covers a particular function in relation to the Tank and product. Sections may reference other sections within this manual and other manuals which also cover this Tank. References made within this manual will normally be for figures, tables, sections, and paragraphs. Operation and maintenance instructions are provided in the form of procedural steps assuming that authorized personnel have previous experience with similar or related equipment.

1-2 GENERAL INFORMATION.

1-2.1 Purpose Of Equipment. The Tank is intended for the storage and transfer of liquid aviator's breathing oxygen. Conversion of this Tank to store liquid nitrogen is authorized only as provided by AF Regulation 54-7.

1-2.2 Physical Description. The Tank is a composite of assemblies as follows:

a. Tank. The Tank is a complete self-contained, skid mounted unit. It has been designed to store liquid oxygen with a low evaporation rate and transfer the liquid into smaller servicing tanks. Forklift slots in the skid and tiedown rings on the sides of the Tank have been provided for lifting requirements.

b. Shells. The Tank consists of an inner shell suspended inside an outer shell. The space between the shell is called the annular space which is insulated and holds a vacuum.

c. Control Housing. The control housing located at the front of the Tank protects and contains the operating controls and indicators.

d. Pressure Buildup Coil (PBC). The PBC is located inside the control housing directly under the Tank fill/drain and servicing lines. The PBC performs as a heat-exchanger where the liquid oxygen is converted into gaseous oxygen. This conversion provides pressure within the inner shell for product transfer and drainage.

e. Relief Devices. The Tank contains relief devices which protect against pressure buildups in the inner shell, fill/drain line, and servicing line that exceed the design parameters.

f. Control Panel. The control panel contains the Tank indicators for determining liquid and pressure levels within

the inner shell. Located below the indicators are the indicator valves and the operating instructions with the Tank flow schematic diagram plaque.

g. Fill/Drain Line (FDL). The FDL is located within the control housing. This line allows the Tank to be filled and drained of product. The FDL components consists of a control valve, relief valve, drain valve, filter, and LOX coupling.

h. Servicing Line (SL). The SL is located within the control housing. This line allows servicing of smaller tanks which in turn service the aircraft. The SL consists of a control valve, relief valve, drain valve, filter, LOX coupling, and service hose.

i. Vapor Vent Manifold (VVM). The VVM and its components are located within the control housing. The vent is located outside of the control housing. This line allows inner shell pressures to be vented outside away from the operating area. VVM components consists of a control valve, relief valve, inner shell safety head, and adjustable pressure control valve.

Table 1-1. Leading Particulars.

Identification:	Liquid Oxygen Storage Tank, Type TMU-7A/E
Manufacturer:	Hydra Rig Cryogenics, Inc., Schulenburg, Texas
Part Number:	C70013
National Stock No. (NSN):	3655-01-245-8408YD
Capacity:	
Gross Volume	2100 gallons
Net Volume	2000 gallons
Weight:	
Empty	12,000 Pounds
Full (Oxygen)	31,054 Pounds
Evaporation Rate:	Less than 70 lbs. of liquid oxygen per 24 hours
Over-All Dimensions:	
Length	192 inches
Width	96 inches
Height	96 inches
Operating Pressure (Inner Tank)	50 psig
Max. Allowable Working Pressure (MAWP)	59 psig
Relief Valve Settings:	
Inner Tank (RV-3)	59 psig
Fill/Drain Line (RV-2)	150 psig
Servicing Line (RV-1)	150 psig
Safety Head Settings:	
Inner Tank (SD-1)	72 psig
Annular Space (SD-2)	0.1 LB. Above atmospheric pressure

1-2.3 Leading Particulars. A summary of leading particulars for the Tank appears in Table 1-1.

1-2.4 Related Publications. The publications listed in Table 1-2 are required and shall be used with this publication, the Repair and Overhaul Instructions, T.O.37C2-8-24-3, and the Illustrated Parts Breakdown, T.O.37C2-8-24-4 in the operation, maintenance, service, and repair of the Tank.

1-2.5 Safety Precautions. Safety precautions related to liquid oxygen and this Tank are listed in the Safety Summary. Safety precautions which are related to specific procedures will appear in the text.

1-2.6 Properties of Liquid Oxygen (LOX). LOX is a pale blue, nonviscous, water-like fluid. At atmospheric pressure it is 1.14 times heavier than water and weighs 9.527 pounds per gallon. LOX boils at -297° F. When LOX is converted to a gaseous state it expands to about 860 times its origional volume. One cubic foot of LOX (7.5 gallons) will expand to about 860 cubic feet of gaseous oxygen at 70° F. For additional information about LOX refer to T.O.42B6-1-1.

1-2.7 Tank Management. This Tank is classified as FSC 3655 registered Air Force Ground Support Equipment. It is to be managed under provisions of AFR 66-1. Using activities will record the USAF registration number located on the

Table 1-2. Related Publications.

Publication No.	Title
T.O.00-5-1	AF Technical Order System
T.O.00-25-107	AFLC Area Support
T.O.00-25-172	Ground Servicing of Aircraft and Static Grounding/Bonding
T.O.00-25-223	Integrated Pressure Systems and Components
T.O.00-25-224	Welding High Pressure and Cryogenic Systems
T.O.00-25-229	Valves and Regulators
T.O.33D2-10-60-1	Cryogenic Sampler
T.O.34Y5-3-37-1	Operation and Maintenance Instructions Power Driven Rotary Vacuum Pump
T.O.00-35D-54	USAF Material Deficiency Reporting and Investigating System
T.O.35-1-3	Painting and Marking of USAF Aerospace Ground Equipment
T.O.37C2-8-29-3	Liquid Oxygen Storage Tank, Overhaul and Repair Instructions
T.O.37C2-8-29-4	Liquid Oxygen Storage Tank, Illustrated Parts Breakdown
T.O.37C2-8-1-116WC-1	Inspection Work Cards
T.O.37C2-8-27-11	Operation, Maintenance and Overhaul Instructions with Illustrated Parts Breakdown Meter, Dual Efficiency
T.O.37C11-3-1	Vacuum Gage (Portable), Part No. 15840
T.O.36G2-3-1	Air Purging Unit, Type GSU-62/M
T.O.37C11-1-1	Cleaning of Pressure Gages Used
T.O.42B6-1-1	Quality Control of Oxygen
AFOSH-STD-127-66	Occupational Safety General Industrial Operations
AFR-144-1	Fuels Management
MIL-STD-1359A	Cleaning Methods and Procedures for Breathing Oxygen Equipment

Tank's data plate. The USAF registration number consists of a 13 digit, alphanumerical arrangement which indicates: (1) The Federal Supply Class, (2) Calendar year in which the Tank was built, (3) Federal Item Identification Number (FIIN) and (4) Assigned Serial Number. When the serial number consists of fewer than four digits, zeros will be added in front of the serial number. Example: Hydra Rig Cryogenics manufactured Tanks, Type TMU-7A/E, NSN 3655-01-087-000lYD and delivered them in the year 1987 with serial numbers beginning with 001.

The Federal Identification Number assigned these Tanks is EAB for LOX tanks. The sample USAF registration number, therefore, would be 3655-01-EAB-0001. Compliance with the afore stated instructions shall be reported in accordance with AFR 66-1 and TO 00-25-215.

1-3 CONSUMMABLE MATERIALS LIST.

1-3.1 Materials used in the maintenance of the Tank at the operating level are listed in Table 1-3.

Table 1-3. Consumable Materials List.

Material	Specification	Federal Stock No.
Tape, Antiseize (1/2-inch)	MIL-T-27730A	8030-00-889-3535
Nitrogen	BB-N-411	6830-00-285-4769
Leak Detection Compound, Oxygen Systems, Type 1	MIL-L-25567C	6850-00-621-1820
Solvent, trichlorotrifluoroethane	MIL-C-81302	

SECTION II
SPECIAL TOOLS AND EQUIPMENT

2-1 GENERAL.

2-1.1 Special tools and equipment required to operate and maintain the Tank are listed in Table 2-1. Items recommended (Figure 2-1,Figure 2-2) are approved tools and test equipment if available. However equivalent items may be used if recommended items are not available.

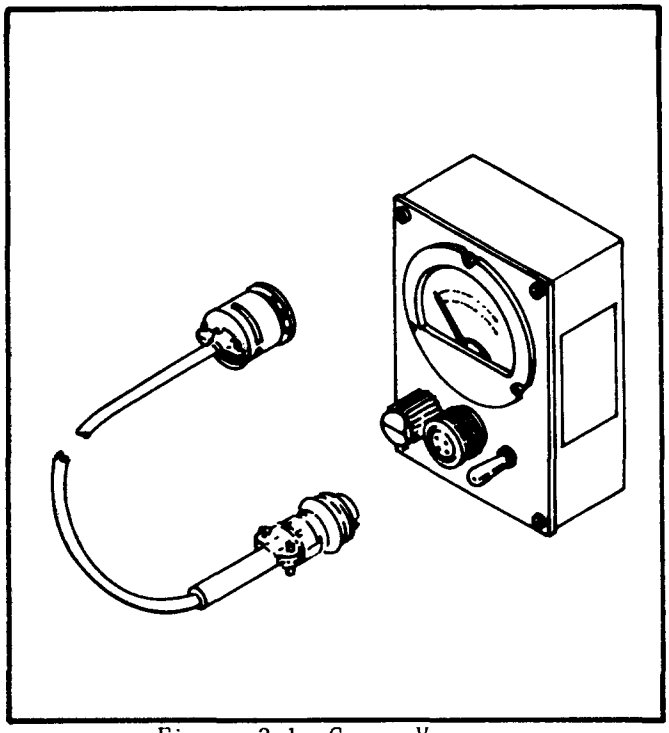


Figure 2-1. Gage, Vacuum.

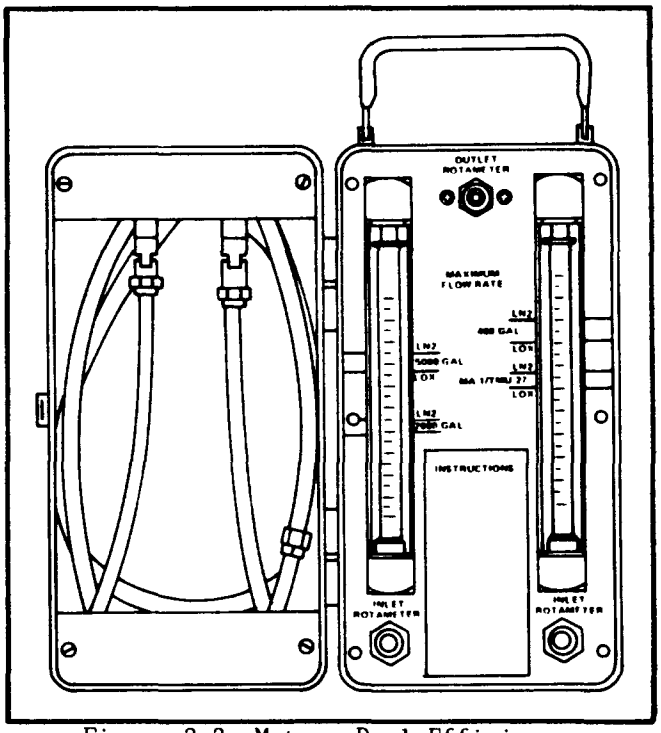


Figure 2-2. Meter, Dual Efficiency.

Table 2-1. Special Tools and Equipment.

SPECIAL TOOLS AND EQUIPMENT LIST

Tool/Equipment Number	Figure Number	Nomenclature	Use and Application
Part No. 15840 NSN 6685-00-115-9602YD	2-1	Vacuum Gage	Determine annulus vacuum level
Part No. 50C-0016-1 NSN 6680-01-117-9931YD	2-2	Dual Efficiency Meter	Check boil-off rate to determine efficiency of annulus vacuum

SECTION III
PREPARATION FOR USE, STORAGE, AND SHIPMENT

3-1 GENERAL.

3-1.1 Scope. This section describes the requirements for the using activity when a Tank is received from the manufacturer.

3-2 PREPARATION FOR USE.

3-2.1 Preparing The Tank. Before a Tank can be put into service, filled with product, or used in transfer operations certain preparations must be accomplished by authorized personnel.

3-2.2 Tank Condition Upon Receipt. When received from the manufacturer the Tank is shipped with the inner shell pressurized with 10-20 psig of clean, dry, oil free nitrogen gas. All valves are closed and the discharge vent is sealed with pressure sensitive tape. The annular space, between the inner and outer shells, has been evacuated to the desired vacuum.

3-3 EXTERNAL SURFACES.

3-3.1 Preparation. The following are items which should be accomplished upon receipt of a Tank.

a. Packing. All external packing used for shipment from the manufacturer must be removed.

b. Cleaning. Remove any oil, grease or other hydrocarbons from the outside surfaces of the Tank with trichlorotrifluoroethane (MIL-C-81302). Observe all safety precautions when using solvents.

c. Inspection. The Tank is given a complete operational and visual inspection before being shipped from the manufacturer. Upon receipt the Tank should be visually inspected for possible damage during shipment or if it is being removed from dry storage before being placed into service. All valves should be closed but if any valves were left open suspect contamination. A basic receiving inspection should include these items:

[1] Inspect the outside of the Tank and inside the control housing for components and piping damage which might affect performance or safety.

CAUTION

Do not check the vacuum line shutoff valve (V-1) or the vacuum indicator shutoff valve (V-2) during valve inspection. Tampering with these valves can result in vacuum loss.

[2] Check all valves for smooth positive operation. Make sure that the valves are left closed after inspection.

[3] Check all welds for indications of cracks.

[4] Check for rust or corrosion.

[5] Make sure that all couplings and vent openings are clean and free from obstructions.

d. Checking Vacuum. Checking the Tank vacuum within the annular space requires a vacuum gage (Refer to Table 2-1 and See Figure 2-1). Procedures for checking the Tank vacuum are found in Section V (Refer to paragraph 5-5.4 and See Figure 5-4).

3-4 LOCATION.

3-4.1 Selection of an Operating Site. Publications used in establishing proper locations for liquid oxygen tanks are listed in Table 1-2.

3-4.2 Type Site. To avoid the accumulation of oxygen vapors from leakage and venting the Tank shall be located in a well ventilated area. The Tank will be placed on a permanent or semi-permanent location with a smooth, level foundation for proper operation. A concrete surface of sufficient size to accomodate transfer operations by delivery vehicles shall be utilized.

3-5 LIFTING AND MOVING THE TANK.

3-5.1 Lifting and Moving Methods (See Figure 3-1). The Tank can be lifted and moved by two (2) methods as follows:

CAUTION

Do not jerk or drop the Tank during any lifting and moving operation.

a. Crane Lifting. When using a crane for lifting and moving the Tank the lifting assemblies (e.g. slings, cables, or chains) shall have a sufficient rating for the Tank weight (12,000 pounds) and G-Loads generated by the Tank weight. The following are minimum requirements for lifting assemblies:

[1] The minimum length of EACH lifting assembly shall be nine (9) feet in length from the lifting eye to the point of lifting.

[2] The minimum rating of EACH lifting assembly shall be 10,000 pounds. This requirement is based upon the tension on each lifting assembly of 7,750 pounds at two (2) G's (1 G is equal to the weight of the Tank).

If lifting assemblies of minimum requirements are not available then a combination of components to meet the minimum requirements is acceptable. Each component must meet the minimum requirements. Attach the lifting assemblies to the top lift rings on the sides of the Tank. Maintain a hoisting angle of at least 60 degrees from the horizontal for safe efficient lifting (maintaining the nine (9) foot length will insure the 60 degree or larger angle). If a spreader bar is to be used make sure its rating is sufficient for the weight involved.

b. Forklift Lifting. When using a forklift for lifting and moving the Tank the lifting capacity of the forklift must be sufficient for the weight of the Tank (12,000 pounds). If a single forklift of sufficient capacity is not available then a combination of forklifts may be used if the combined lifting capacity is adequate for the weight involved. Six (6) forklift slots have been provided in the skid frame on each side of the Tank. Make sure the forklift tines are fully inserted in these slots before attempting to lift the Tank. Maintain the Tank in a horizontal position during lifting and moving the Tank.

3-6 STATIC GROUNDING.

3-6.1 Grounding Requirements. Prior to designated operations the Tank shall be grounded against the effects of static electricity (See Figure 3-2).

3-7 PREPARATION FOR STORAGE AND SHIPMENT.

3-7.1 Prior to shipment or storage certain preparations and tasks must be accomplished. This Tank HAS NOT been designated for shipment with product.

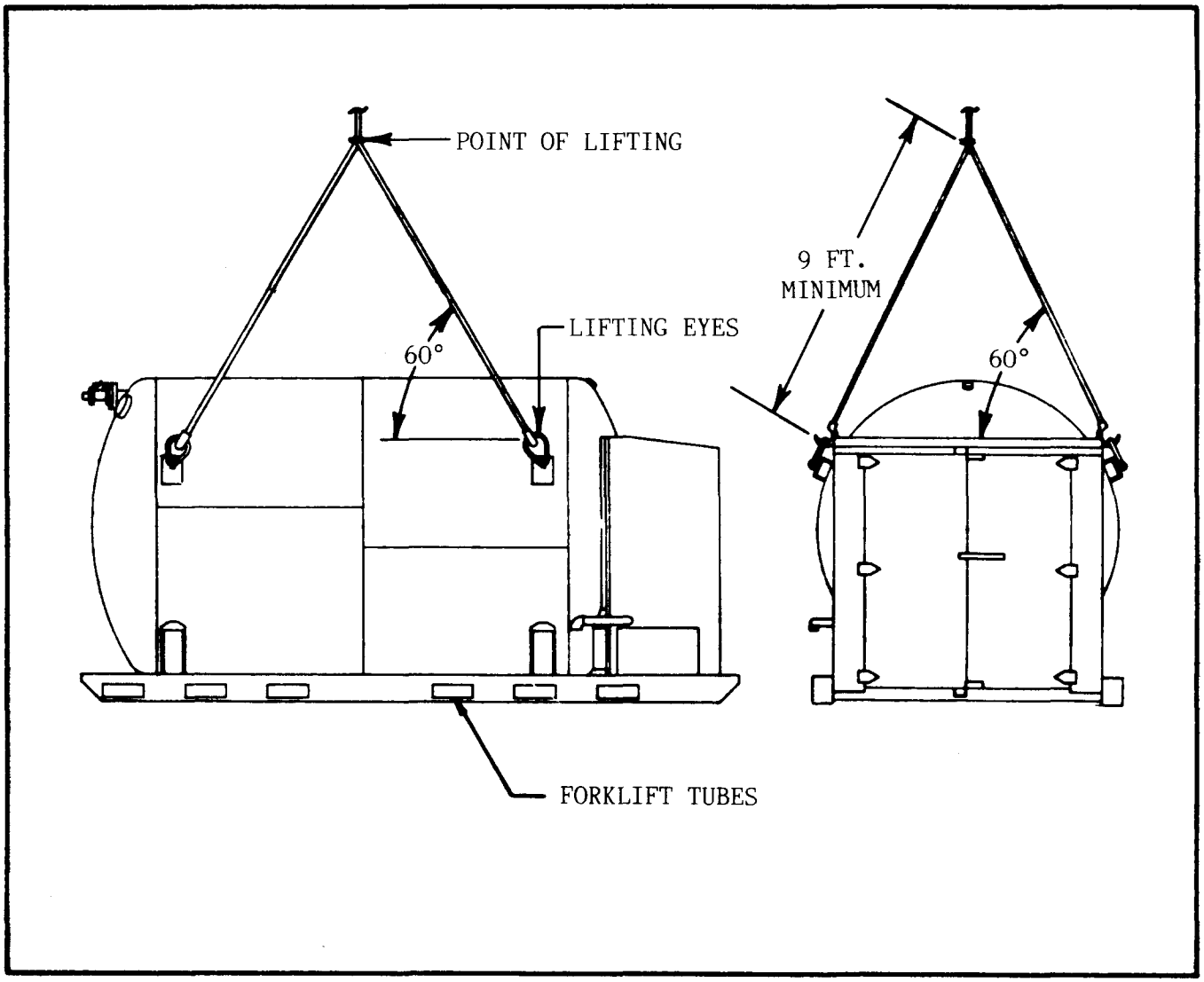


Figure 3-1. Lifting Instructions.

3-7.2 General Preparations. Prior to shipment or storage certain procedures and tasks must be accomplished. These tasks must be completed in the order as follows:

a. Drain the Tank of all liquid product (Refer to Section IV).

b. Purge the Tank and pressurize the inner shell with 10-20 psig of clean, dry, oil free nitrogen gas (Refer to Section IV, T.O.37C2-8-29-3).

c. Check the Tank vacuum (Refer to Section V in this publication).

d. Lifting and moving the Tank (Refer to paragraph 3-5 in this section).

3-7.3 Tank Shipment. After the Tank has been properly prepared it is ready for the designated type of shipment (Air or ground). While the Tank is not fragile it should not be subjected to any sudden vertical or horizontal acceleration. DO NOT DROP. Markings for shipment shall be in accordance with MIL-STD-129.

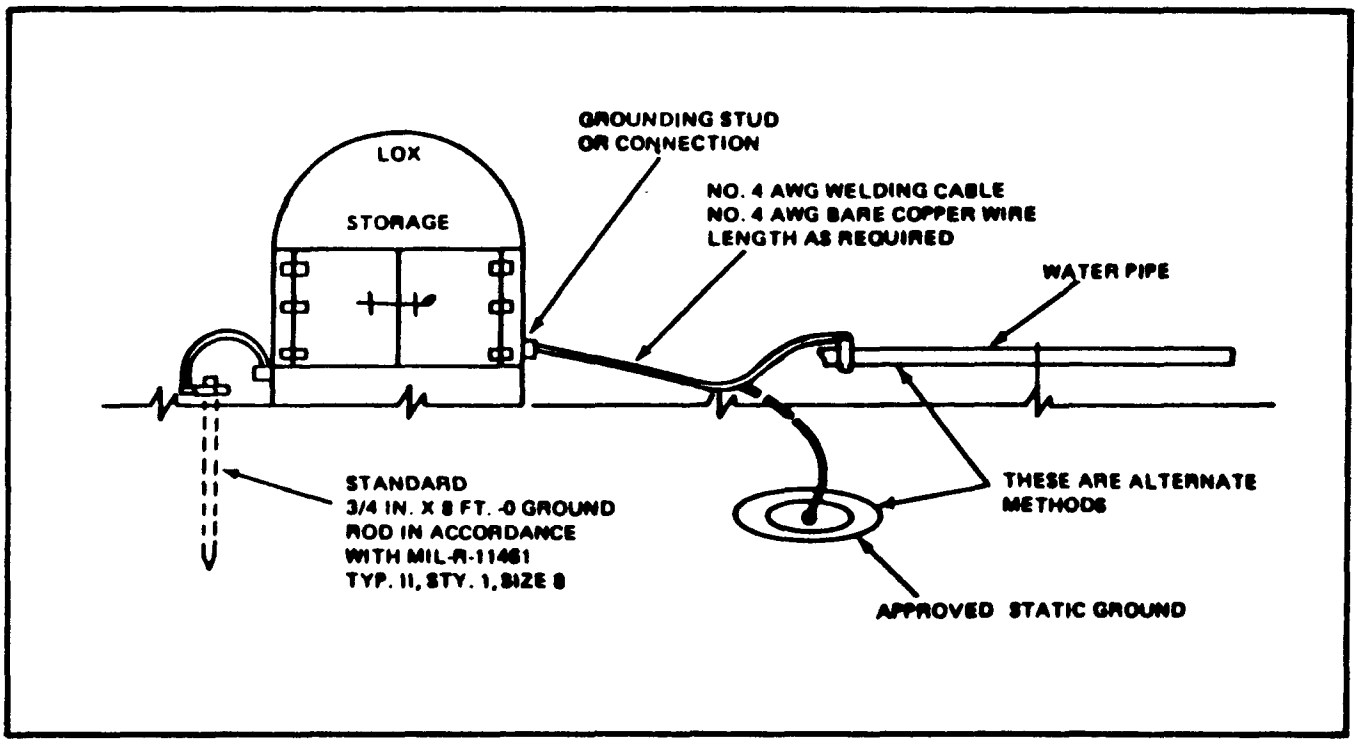


Figure 3-2. Approved Method for Static Grounding.

3-7.4 Tank Storage. Prior to storage the Tank must be prepared as follows:

a. Accomplish steps a thru c as outlined in paragraph 3-7.2 in this section.

b. Clean the exterior of the Tank (See paragraph 3-3, b, in this section). All All loose or chipped paint and all solvents must be removed. If necessary paint the Tank in accordance with T.O.35-1-3.

c. Replace all damaged decals.

d. Prepare a tag (Specification UU-T-81 or equivalent) to indicate the date of preparation for storage, the pressure of the dry nitrogen in the inner shell, the date and level of vacuum, and the date of the last evacuation.

SECTION IV
OPERATING INSTRUCTIONS

4-1 THEORY OF OPERATION (See Figure 4-1 and Figure 6-1).

4-1.1 The Tank is a self-contained, skid mounted unit designed to be filled with product (LOX), store the product until needed, and transfer the product to smaller aircraft servicing tanks. The design incorporates two (2) shells with one (1) shell (inner) suspended inside the other shell (outer). The inner shell contains the product and the outer shell contains the insulation and vacuum which is also called the annular space. The annular space provides a heat barrier to prevent the loss (boil off) of product within the inner shell.

4-1.2 Transfer of product is accomplished by use of a pressure difference. The pressure required for transfer operations is created by the pressure buildup coil (PBC). The PBC acts as a heat exchanger which changes liquid product into gas through vaporization. The gaseous product fills the area within the inner shell above the liquid product thereby creating a positive pressure for product transfer. When the inner shell pressure is greater than the receiving tank pressure the physical requirements exist for product transfer.

4-2 OPERATING CONTROLS (See Figure 4-1).

4-2.1 Purpose and Use of Operating Controls. The purpose and use of the Tank operating controls is as follows:

a. Servicing Line Shutoff Valve (V-3). The purpose of V-3 is to start and stop the flow of product through the servicing line. V-3 is used by the operator when servicing receiving tanks to start, contol, and stop the flow of product.

b. Servicing Line Drain Valve (V-4). The purpose of V-4 is to drain off pressure from the servicing line. V-4 is used by the operator to drain servicing line pressure before disconnecting the service hose after transfer operations.

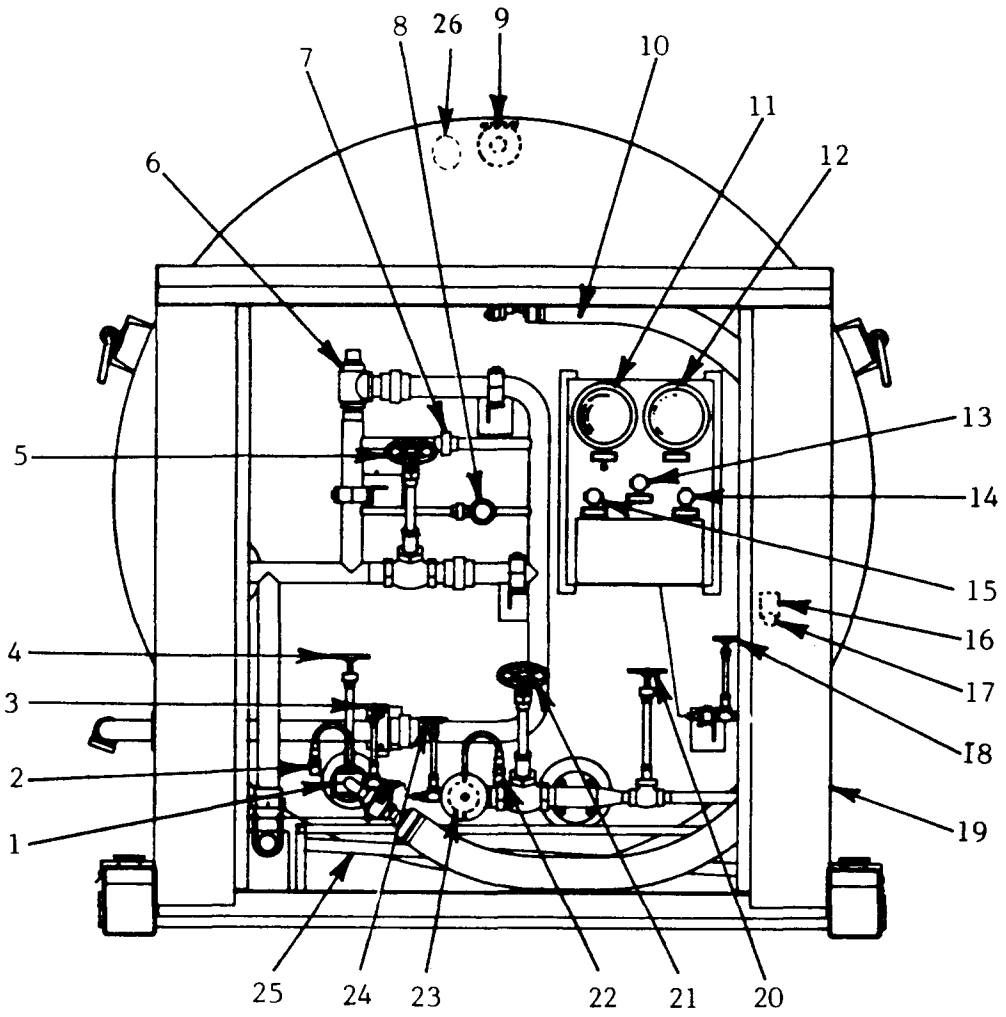
c. Fill/Drain Line (FDL) Shutoff Valve (V-5). The purpose of V-5 is to start and stop the flow of product through the FDL. V-5 is used by the operator when filling or draining the Tank to start, control, and stop the flow of product.

d. Fill/Drain Line (FDL) Drain Valve (V-6). The purpose of V-6 is to drain off pressure from the FDL. V-6 is used by the operator to drain FDL pressure before disconnecting the hose used in fill and drain operations.

e. Pressure Buildup Coil (PBC) Shutoff Valve (V-7). The purpose of V-7 is to allow liquid product flow to the PBC. V-7 is used by the operator during Tank operations for building pressure within the inner shell. Once the operating pressure for the inner shell is obtained V-7 is used to replace pressure losses that may occur during Tank operations.

f. Vapor Vent Line (VVL) Shutoff Valve (V-8). The purpose of V-8 is to vent gaseous product within the inner shell. V-8 is used by the operator during Tank operations for relieving inner shell pressure which exceed the normal operating pressure. V-8 is also used (left open) when the Tank is in the idle mode.

g. Adjustable Pressure Control Valve (PC-1). The purpose of PC-1 is to allow automatic venting of inner shell pressure in order to maintain the inner shell pressure at the desired level.



1. Servicing Line Filter (F-1)
2. Servicing Line Relief Valve (RV-1)
3. Servicing Line Drain Valve (V-4)
4. Servicing Line Shutoff Valve (V-3)
5. Vapor Vent Line Shutoff Valve (V-8)
6. Inner Shell Pressure Relief Valve (RV-3)
7. Inner Shell Safety Head (SD-1)
8. Adjustable Pressure Control (PC-1)
9. Vacuum Line Shutoff Valve (V-1)
10. Service Hose
11. Vapor Phase Pressure Indicator (PI-1)
12. Tank Liquid Level Indicator (LL-1)
13. Level Indicator Isolation Valve (V-12)
14. Level Indicator Isolation Valve (Vapor V-10)
15. Level Indicator Isolation Valve (Liquid V-11)
16. Vacuum Indicator Shutoff Valve (V-2)
17. Vacuum Sensor
18. Full Trycock Valve (V-9)
19. Control Housing
20. Pressure Buildup Control Valve (V-7)
21. Fill/Drain Line Shutoff Valve (V-5)
22. Fill/Drain Safety Relief Valve (RV-2)
23. Fill/Drain Line Filter (F-2)
24. Fill/Drain Line Drain Valve (V-6)
25. Pressure Buildup Coil
26. Outer Shell Safety Head (SD-2)

NOTE: Instrumentation, piping, and valves are not shown for clarity. This illustration is for component identification only.

Figure 4-1. Component Identification.

h. Level Indicator Isolation Valve (Vapor) (V-10). The purpose of V-10 is to isolate the vapor phase pressure indicator (PI-1) from the gaseous pressure in the inner shell. V-10 is used by the operator to zero (0) the Tank liquid level indicator (LL-1). V-10 is used by maintenance personnel to prevent gaseous product flow through the V-10 lines when replacing LL-1 or the level indicator equalizer valve (V-12).

i. Level Indicator Isolation Valve (Liquid) (V-11). The purpose of V-11 is to isolate the Tank liquid level indicator (LL-1) from the liquid pressure in the inner shell. V-11 is used by the operator to zero (0) LL-1. V-11 is used by the maintenance personnel to prevent product flow through the V-11 lines when replacing LL-1 or the level indicator equalizer valve (V-12).

j. Level Indicator Equalizer Valve (V-12). The purpose of V-12 is to isolate between the level indicator isolation valves (V-10 and V-11). V-12 is used by the operator to zero (0) the Tank liquid level indicator (LL-1), normally closed.

k. Full Trycock Valve (V-9). The purpose of V-9 is to indicate when the Tank is at or near its full capacity. V-9 is used by the operator during filling operations. When liquid streams from V-9 the Tank is near or at full capacity.

4-3 ADDITIONAL TANK EQUIPMENT.

4-3.1 Purpose and Use of Additional Tank Equipment (See Figure 4-1). The purpose of other Tank components is as follows:

a. Vacuum Line Shutoff Valve (V-1). The purpose of V-1 is to provide a means for pumping out the annular space thus creating a vacuum between the inner and outer shell. V-1 is use by maintenance personnel during pump out operations to attach the pump out hose and to isolate the annular space after pump out operations have been completed.

b. Vacuum Indicator Shutoff Valve (V-2). The purpose of V-2 is to isolate the annular space which holds the vacuum from the vacuum sensor (thermocouple). V-2 is used by maintenance personnel when a vacuum check is required for the Tank.

c. Vacuum Sensor (Thermocouple). The purpose of the vacuum sensor is to provide a means of attaching a vacuum gage. The vacuum sensor is used by maintenance personnel when taking a required vacuum reading of the annular space.

d. Pressure Buildup Coil (PBC). The purpose of the PBC is to convert liquid product into gaseous product. The PBC is used by the operator to build pressure within the inner shell for Tank operations.

e. Service Hose. The purpose of the service hose is to provide a means of transferring liquid product to receiving tanks. The service hose is used by the operator when servicing tanks during transfer operations.

f. Servicing Line Filter (F-1). The purpose of F-1 is to filter impurities when servicing other tanks. F-1 is used during operations but does not contain any control devices. When required F-1 is changed by maintenance personnel and recycled after being cleaned.

g. Fill/Drain Line Filter (F-2). The purpose of F-2 is to filter impurities when being filled by delivery vehicles. F-2 is used during operations but does not contain any control devices. When required F-2 is changed by maintenance personnel and recycled after cleaning.

h. Servicing Line (SL) Pressure Relief Valve (RV-1). The purpose of RV-1 is to relieve pressure buildup in the SL. RV-1 is used as a safety device during and after servicing operations in the event that liquid product becomes trapped in the SL . RV-1 operates and resets automatically.

i. Fill/Drain Line (FDL) Pressure Relief Valve (RV-2). The purpose of RV-2 is to relieve pressure buildup in the FDL. RV-2 is used as a safety device during and after filling and draining operations in the event that liquid product is trapped in the FDL. RV-2 operates and resets automatically.

j. Inner Shell Pressure Relief Valve (RV-3). The purpose of RV-3 is to relieve pressure buildup within the inner shell. RV-3 is used as a safety device if over pressure conditions develope within the inner shell during operations or when the Tank is in the idle mode. RV-3 operates and resets automatically.

k. Inner Shell Safety Head (SD-1). The purpose of SD-1 is relieve inner shell pressure buildup if the inner shell pressure relief valve (RV-3) fails to open. SD-1 is used as a safety device if RV-3 fails to operate when inner shell pressure exceeds safe limits. SD-1 must be replaced by maintenance personnel if it ruptures.

l. Outer Shell Safety Head (SD-2). The purpose of SD-2 is to relieve any pressure buildup within the annular space. SD-1 is used as a safety device for the outer shell if a leak developes on the inner shell. SD-2 can also indicate that the vacuum has been lost within the annular space.

m. Tank Liquid Level Indicator (LL-1). The purpose of LL-1 is to indicate the level of liquid product inside the inner shell. LL-1 is used by the operator in determining if enough product exist within the inner shell to perform servicing operations, if the Tank needs to be filled with product, and the capacity requirements of the receiving tank should the Tank need to be drained.

n. Vapor Phase Pressure Indicator (PI-1). The purpose of PI-1 is to indicate the pressure within the inner shell. PI-1 is used by the operator to determine when normal operating pressure for Tank operations is sufficient, when operating pressure needs to be increased during operations, and when operating pressure begins to exceed safe limits.

4-4 OPERATING INSTRUCTIONS.

4-4.1 Basic Instructions. All operating controls appear in Figure 4-1 and the basic valve positions for each function is shown in Table 4-1. There is a procedure to be followed for each function. Operational procedures are outlined in the following paragraphs.

4-5 FILLING THE TANK.

4-5.1 Types of Fillings. Two seperate procedures exist for filling a Tank. One procedure is for a Tank that is ambient or a Tank that has been purged. The other procedure is for a Tank that is chilled due to an amount of product still in the inner shell. The following are basic requirements before filling an ambient/purged or chilled Tank. These requirements are as follows:

a. Review the Safety Summary.

b. Wear protective equipment.

c. Use caution when disconnecting the supply hose from the fill/drain line LOX coupling.

4-5.2 Filling An Ambient/Purged Tank (See Figure 4-1). Follow these procedures during the first filling of a Tank, filling a Tank that has been out of service, or any time that the inner shell is at ambient temperature. These procedures will allow the inner shell to chill evenly and avoid possible deformation and excessive loss of product. The procedure is as follows:

a. Remove dust caps, purge, and connect the supply hose from the supply source to the fill/drain line (FDL) coupling.

Table 4-1. Valve Positions During Tank Operations.

Valve Symbol	Valve Name	Tank Filling	Pressure Buildup	LOX Transfer	Gravity Drain	Pressure Drain	Constant Pressure	Liquid Storage	Tank Empty
V-3	Service	Closed	Closed	Open	Closed	Closed	Closed	Closed	Closed
V-4	Service Drain	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
V-5	Fill/Drain	Open	Closed	Closed	Open	Open	Closed	Closed	Closed
V-6	Fill/Drain Drain	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
V-7	Pressure Buildup	Closed	Open	*	Closed	Open	Closed	Closed	Closed
V-8	Vapor Vent	Open	Closed	Closed	Open	Closed	Closed	Closed	Closed
V-9	Full Trycock	Open	Closed	Closed	Closed	Closed	Closed	Closed	Closed
PC-1	Adjust. Pressure Control	**	**	**	**	**	Automatic	**	**

* V-7 may be opened intermittently during product transfer to maintain desired pressure.
** PC-1 is set to relieve automatically at a predetermined pressure for constant pressure operation. This automatic feature may interfere with such other operations as pressure buildup, filling, transfer, and pressure drain. PC-1 may have to be set to a higher pressure, depending on the particular operation.

b. Open the full trycock valve (V-9) (18).

c. Open the vapor vent line shutoff valve (V-8) (5).

d. Open the liquid level isolation valves (V-10) (14) and (V-11) (15).

e. Check and adjust the adjustable pressure control valve (PC-1) (8) if necessary.

f. Open the FDL shutoff valve (V-5) (21).

g. Check that all other valves not required for filling operations are closed.

h. Slowly open the supply source valve and maintain 10 psig during initial filling of a warm Tank.

CAUTION

Do not exceed the 2000 gallon capacity of the Tank.

i. Close the source valve when liquid product begins to spurt from the full trycock valve's discharge line.

j. Quickly, close the V-5 and open the FDL drain valve (V-6) (24) to drain trapped product in the supply hose.

k. Disconnect the supply hose, close V-6 and install dust caps on couplings.

l. Close V-8 and V-9 after excessive venting has stablized.

NOTE

After the Tank is filled fluctuating pressures may cause an inaccurate display on the Tank liquid level indicator until the Tank has stablized.

m. Check product quanity on the liquid level indicator (LL-1) (12).

n. Open V-8, if no additional Tank operations are scheduled, placing the Tank in the idle mode.

4-5.3 Filling A Chilled Tank (See Figure 4-1). Follow these procedures when filling a Tank that is low on liquid product. The procedure is as follows:

a. Open the fill/drain line (FDL) drain valve (V-6) (24) to make sure no product is under pressure, due to a leaking FDL shutoff valve (V-5) (21). If no product vents then close V-6.

b. Remove dust caps, purge, and connect the supply hose from the supply source to the FDL coupling.

c. Open the full trycock valve (V-9) (18).

d. Open the vapor vent line shutoff valve (V-8) (5).

e. Open the liquid level isolation valves (V-10) (14) and (V-11) (15).

f. Check and adjust the adjustable pressure control valve (PC-1) (8) if necessary.

g. Open the FDL shutoff valve (V-5).

h. Check that all other valves not required for filling operations are closed.

i. Slowly open the supply source valve and transfer will begin.

CAUTION

Do not exceed the 2000 gallon capacity of the Tank.

j. Close the source valve when liquid product begings to spurt from the full trycock valve's discharge line.

k. Quickly, close V-5 and open V-6 to drain trapped product in the supply hose.

l. Disconnect service hose, close V-6 and install dust caps on couplings.

m. Close V-8 and V-9 after excessive venting has stablized.

NOTE

After the Tank is filled fluctuating pressures may cause an inaccurate display on the Tank liquid level indicator until the Tank has stablized.

n. Check Tank quanity on the liquid level indicator (LL-1) (12).

o. Open V-8, if no additional Tank operations are scheduled, placing the Tank in the idle mode.

4-6 SERVICING WITH THE TANK.

4-6.1 Servicing Tanks With Product (See Figure 1-4). The Tank is designed to operate at pressures up to 50 psig. Observe all safety precautions and wear protective clothing. Use caution when disconnecting the servicing hose. When transferring product the procedures are as follows:

a. Open the servicing line (SL) drain valve (V-4) (3) to make sure no product is under pressure, due to a leaking SL shutoff valve (V-3) (4). If no product vents then close V-4.

b. Prepare the receiving tank to be serviced by the Tank in accordance with applicable Technical Orders.

c. Check that all valves are closed except the liquid level isolation valves (V-10) (14) and (V-11) (15).

d. Check and adjust the adjustable pressure control valve (PC-1) (8) if necessary.

CAUTION

Do not exceed the operating pressure of 50 psig.

e. Slowly, open the pressure buildup control valve (V-7) (20) and build pressure to 50 psig on the vapor phase pressure indicator (PI-1) (11). Operate V-7 and vapor vent line shutoff valve (V-8) (5) as necessary to maintain transfer pressure.

f. Remove service hose (10) from the control housing. Remove the dust cap and purge service hose by opening V-3. Close V-3 after purging.

g. Connect the service hose to the receiving tank fill coupling.

h. Open the receiving tank fill valve and SLOWLY open V-3. Fill the receiving tank to the desired level.

i. After the receiving tank has been serviced close V-3 and the receiving tank fill valve.

j. Quickly, open V-4 to drain the product and pressure from the service hose. After draining the service hose close V-4.

NOTE

If more than one receiving tank is to be filled, retain the pressure in the Tank until all tansfers have been completed.

k. Open V-8 to relieve Tank pressure. Disconnect the service hose, install the dust cap on the coupling and return the service hose to the control housing.

l. If no additional Tank operations are scheduled leave V-8 open, placing Tank in the idle mode.

4-7 DRAINING THE TANK.

4-7.1 Draining Product From The Tank.

(See Figure 4-1). The Tank can be drained by gravity or by pressure. If gravity draining is desired the operator only needs to open the fill/drain line (FDL) shutoff valve (V-5) (21) after making the proper connections. Follow these procedures when pressure draining the Tank:

WARNING

Ensure that the container and area is free of all hydrocarbons.

a. Connect a suitable hose to the fill/drain line (FDL) coupling and to a suitable container.

NOTE

The Tank can be drained using the servicing line if desired.

b. Ensure all valves are closed except the liquid level isolation valves (V-10) (14) and (V-11) (15).

c. Check and adjust the adjustable pressure control (PC-1) (8) if necessary.

CAUTION

Do not exceed the operating pressure of 50 psig.

d. Slowly, open the pressure buildup control valve (V-7) (20) and build draining pressure desired by monitoring the vapor phase pressure indicator (PI-1) (11). If necessary, operate V-7 to maintain draining pressure.

e. Open the FDL shutoff valve (V-5) (21) and drain the Tank until product flow ceases and PI-1 reads zero (0).

f. Close V-5 and V-7 if necessary.

g. Disconnect the hose from the FDL coupling and re-install the dust cap.

4-8 PRODUCT SAMPLING.

4-8.1 Obtaining Product Samples (See Figure 4-1). Periodically it will be necessary to obtain samples of the product for testing (Refer to T.O.37C2-8-1-116WC-1). Observe all safety precautions, wear protective clothing and equipment, and use caution when disconnecting sampler hoses. Follow these procedures when draining product samples from the Tank:

a. Open the servicing line (SL) drain valve (V-4) (3) to ensure there is no leakage from the SL shutoff valve (V-3) (4). Close V-4 in no product vents.

b. Prepare the sampler in accordance with applicable Technical Orders.

c. Check that all valves are closed except the liquid level isolation valves (V-10) (14) and (V-11) (15).

d. Check and adjust the adjustable pressure control valve (PC-1) (8) if necessary.

CAUTION

Do not exceed the operating pressure of 50 psig.

e. Slowly, open the pressure buildup control valve (V-7) (20) and build pressure to 50 psig on the vapor phase pressure indicator (PI-1) (11). Operate V-7 and vapor vent line shutoff valve (V-8) (5) as necessary to maintain transfer pressure.

f. Remove service hose (10) from the control housing. Remove the dust cap and purge the service hose by opening V-3. Close V-3 after purging.

g. Connect the service hose to the product sampler.

h. Prepare the sampler and SLOWLY open V-3.

i. After the sample has been taken close V-3.

j. Quickly, open V-4 to drain the product and pressure from the service hose. After draining the service hose close V-4.

k. Open V-8 to relieve Tank pressure. Disconnect the service hose from the sampler, install dust cap on the coupling and return the service hose to the control housing.

l. Dispose of the product sample in accordance with proper directives.

NOTE

When purging is indicated by an unsatisfactory sample of the product refer to the Repair and Overhaul Instructions, T.O. 37C2-8-29-3 for purging procedures.

SECTION V
MAINTENANCE INSTRUCTIONS

5-1 INSPECTION AND PREVENTIVE MAINTENANCE.

5-1.1 Scope. This section contains the necessary procedures for maintaining the Tank when it contains liquid product. Only qualified personnel shall be authorized to perform maintenance on the Tank. Maintenance personnel must keep parts being removed and replaced free from hydrocarbons.

5-1.2 Periodic Inspection. Refer to T.O. 37C2-8-1-116WC-1 (Inspection Work Cards).

5-1.3 Periodic Lubrication. No periodic lubrication is required for this Tank.

5-1.4 Troubleshooting. Refer to Table 5-1 for troubleshooting procedures for common malfunctions, probable causes, and remedies. Component references are to Figure 4-1.

5-1.5 General Maintenance Instructions. Maintenance personnel must keep all parts used in handling liquid oxygen free from hydrocarbons. All parts that are removed or left exposed on the Tank must be sealed in polyethylene bags until reassembly. All anti-seize tape must be removed and replaced on threaded parts. When replacing anti-seize tape start with the third thread from the end.

5-1.6 A clogged filter should be suspected whenever flow is reduced through the servicing or fill/drain lines with the valve fully opened and the Tank pressurized. Filters may be changed at the operational level in accordance with the following instructions in this section.

5-2 Fill/Drain Line Components.

5-2.1 Fill/Drain Line (FDL) Filter (F-2) (See Figure 5-1). Removal and replacement of F-2 is as follows:

a. Ensure that all valves are closed except the vapor vent line shutoff valve (V-8). The dust cap (2) should remain installed on the FDL coupling (4).

b. Remove small drain line (6) connecting the drain valves (9 and 12). Cover the exposed orifices on the drain line tee (7).

c. Open drain valve (9) completely and remove the stem/bonnet assembly (10).

d. Remove bolts (14) from the pipe clamp (15) and remove (16 and 17). Remove nuts (18), lockwashers (19), and bolts (20). Remove support brace (21) by tapping it towards the Tank.

e. Support the filter (23) to prevent movement and remove manifold (22) from (23).

f. Support the manifold (24) to prevent it from turning and remove filter (23). Dispense of the filter through proper channels for cleaning.

g. Put anti-seize tape on the male threads of the manifold (24) and install a new filter making sure the arrow is pointed towards the Tank.

h. Put anti-seize tape on the male threads of manifold (22) and install

(22) into filter (23). Ensure the globe valve body nipple is in position for installation of the small drain line (6).

i. Tap support brace (21) into position and install bolts (20), lockwashers (19), and nuts (18).

j. Reassemble the pipe clamp (15) over the manifold (22) and install bolts (14).

CAUTION

Ensure that globe valves are in the full open position before reassembling the stem/bonnet assembly into the valve body. This will prevent damaging the components which seat the valve upon assembly.

k. Reassemble the stem/bonnet assembly (10) into body (11) of the FDL drain valve.

l. Install the small drain line (6).

m. Leak test threaded joints.

5-2.2 Fill/Drain Line (FDL) Drain Valve (V-6) (See Figure 5-1). Removal and replacement of V-6 is as follows:

a. Remove the small drain line (6) and cover drain line tee (7).

b. Remove the male connector (8).

c. Open V-6 (9) and remove the stem/bonnet assembly (10).

d. Disassemble (10) as required (Refer to the Repair and Overhaul Instructions, T.O.37C2-8-29-3).

e. Remove body (11) from manifold (22).

f. Put anti-seize tape on the male threads of manifold (22) to which body (11) is mounted and install (11).

CAUTION

Make sure globe valves are in the full open position before reassembling the stem/bonnet assembly into the valve body. This will prevent damaging the components which seat the valve upon assembly.

g. If the stem/bonnet assembly (10) was disassembled to effect repairs reassemble (10) (Refer to T.O.37C2-8-29-3).

h. Reassemble the stem/bonnet assembly (10) into body (11).

i. Put anti-seize tape on male connector (8) and install (8) in body (11).

j. Re-install the small drain line (6).

k. Leak test the threaded joints.

5-2.3 Fill/Drain Line (FDL) Pressure Relief Valve (RV-2) (Figure 5-1). Removal and replacement of RV-2 is as follows:

a. Support manifold tubing and remove RV-2 (13) from manifold (22).

b. Put anti-seize tape on the male threads of the relief valve. Support manifold tubing and install a new RV-2 (13).

c. Leak test the threaded joint.

d. Test the valve's pressure opening after leak testing the threaded joints. For the pressure opening setting refer to Table 1-1.

5-2.4 Fill/Drain Line (FDL) LOX Coupling (Figure 5-1). Removal and replacement of the FDL LOX coupling is as follows:

a. Remove LOX coupling (1) from the hex bushing (5). If further disassembly is required remove dust cap (2) and gasket (3) from the coupling seat (4).

b. Put anti-seize tape on the hex bushing (5) and install LOX coupling (1).

c. Leak test the threaded joints.

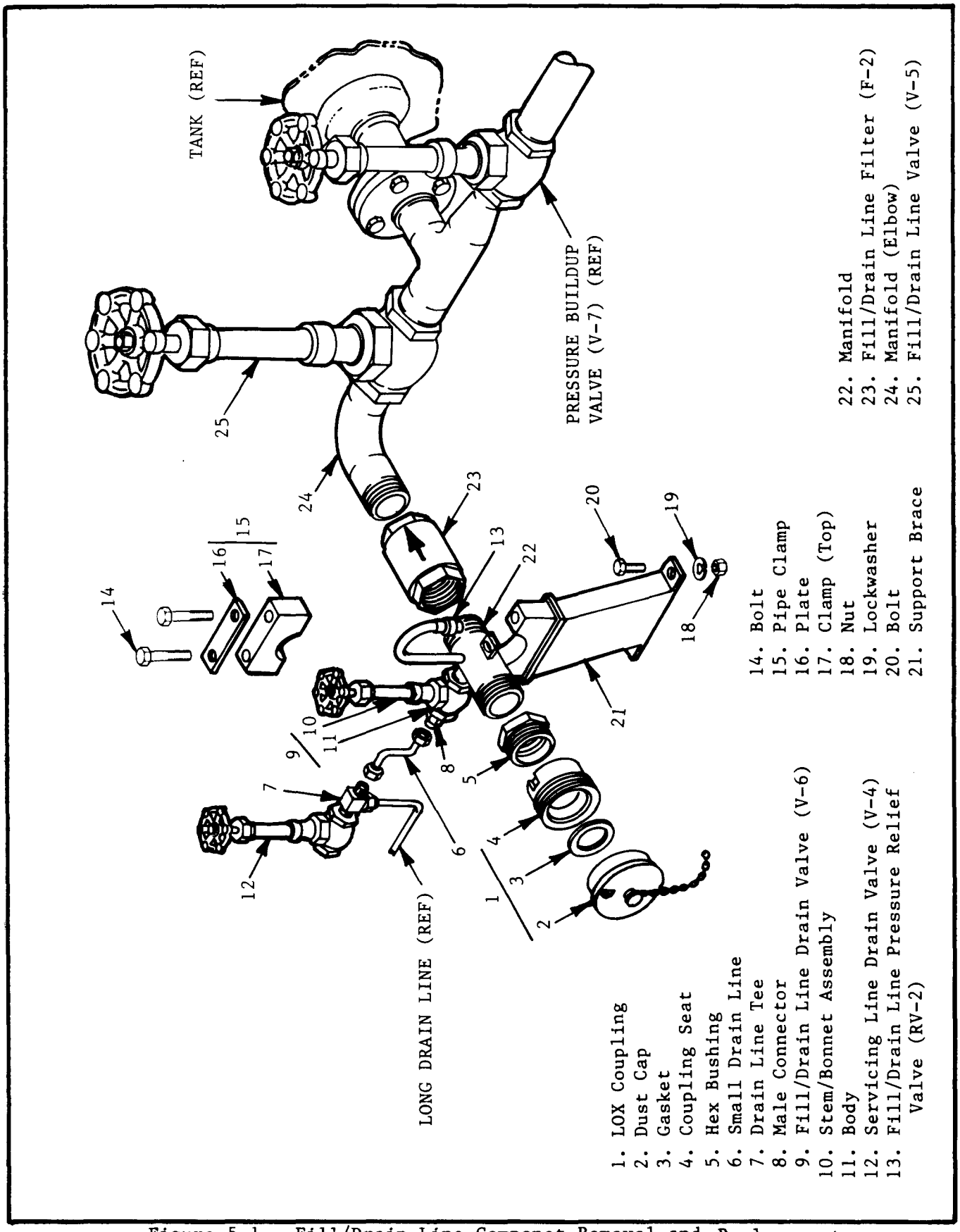


Figure 5-1. Fill/Drain Line Componet Removal and Replacement.

5-3 SERVICING LINE COMPONENTS.

5-3.1 Servicing Line (SL) Filter (F-1) (See Figure 5-2). Removal and replacement of F-1 is as follows:

a. Ensure that all valves are closed except the vapor vent line shutoff valve (V-8).

b. Disconnect the service hose and cover the end.

c. Remove the small drain line (5) connecting the drain valves (12 and 22). Cover the exposed orifices on the male connector (7).

d. Disconnect the long drain line (8) from tee (6) and cover the exposed end of tee (6).

e. Open drain valve (12) completely and remove the stem/bonnet assembly (13).

f. Remove bolts (15) from the pipe clamp (16) and remove (17 and 18).

g. Support the filter (19) to prevent movement and remove manifold (9) from filter (19).

h. Support the pipe nipple (20) to prevent movement and remove filter (19). Dispense of the filter through proper channels for cleaning.

i. Put anti-seize tape on the male threads of the pipe nipple (20) and install a filter making sure the arrow is pointed away from the Tank.

j. Put anti-seize tape on the male threads of the manifold (9). Support filter (19) and install manifold (9) into filter (19). Ensure that the globe valve body is in the correct position for installing drain lines (5 and 8).

k. Reassemble the pipe clamp (16) over the manifold (9) and install bolts (15).

1. Connect the long drain line (8) and install the small drain line (5).

CAUTION

Ensure that globe valves are in the full open position before reassembling the stem/bonnet assembly into the valve body. This will prevent damaging the components which seat the valve upon assembly.

m. Reassemble the stem/bonnet assembly (13) into body (14) of the SL drain valve (12).

n. Leak test threaded joints.

5-3.2 Servicing Line (SL) Drain Valve (V-4) (See Figure 5-2). Removal and replacement of V-4 is as follows:

a. Remove the small drain line (5) and cover male connector (7).

b. Disconnect the long drain line (8) from tee (6).

c. Remove the drain line tee (6).

d. Open V-4 (12) and remove the stem/bonnet assembly (13).

e. Disassemble (12) as required (Refer to the Repair and Overhaul Instructions, T.O. 37C2-8-29-3).

f. Remove body (14) from manifold (9).

g. Put anti-seize tape on the male threads of manifold (9) to which body (14) is mounted and install (14).

CAUTION

Make sure globe valves are in the full open position before reassembling the stem/bonnet assembly into the valve body. This will prevent damaging the components which seat the valve upon assembly.

h. If the stem/bonnet assembly (13) was disassembled to effect repairs reassemble (13) (Refer to T.O. 37C2-8-29-3).

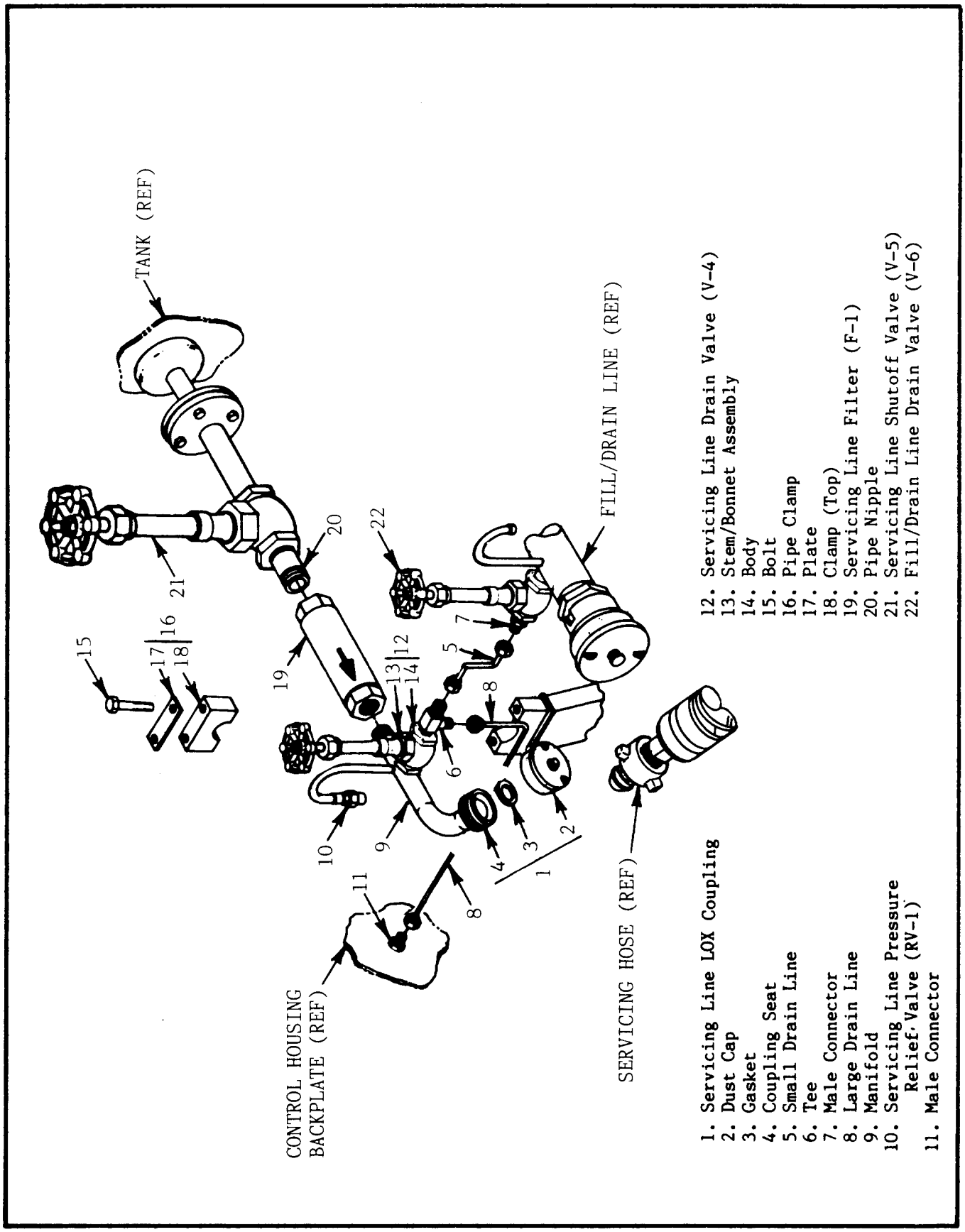


Figure 5-2. Servicing Line Component Removal and Replacement.

i. Reassemble the stem/bonnet assembly (13) into body (14).

j. Put anti-seize tape on the male threads of tee (6) and install (6) into body (14).

k. Reinstall the small drain line (5) and connect long drain line (8).

l. Leak test the threaded joints.

5-3.3 Servicing Line (SL) Pressure Relief Valve (RV-1) (Figure 5-2). Removal and replacement of RV-1 is as follows:

a. Support manifold tubing and remove RV-1 (10) from manifold (9).

b. Put anti-seize tape on the male threads of the relief valve. Support manifold tubing and install a new relief valve RV-1 (10).

c. Leak test the threaded joints.

d. Test the valve's pressure opening after leak testing. For the pressure opening setting refer to Table 1-1.

5-3.4 Servicing Line (SL) LOX Coupling (Figure 5-2). Removal and replacement of the SL LOX coupling is as follows:

a. Disconnect the servicing hose and cover the end.

b. Remove LOX coupling (1) from the manifold (9). If further disassembly is required remove dust cap (2) and gasket (3) from the coupling seat (4).

c. Put anti-seize tape on the male threads of manifold (9) and install LOX coupling (1).

d. Leak test the threaded joints.

5-4 CONTROL PANEL COMPONENTS.

5-4.1 Liquid Level Indicator (LL-1) (Figure 5-3). Removal and replacement of LL-1 is as follows:

a. Close the level indicator isolation valves (17 and 18). If the level indicator equalizer valve (10) is not already in the closed position then close (10).

b. Remove line tubes (1 and 2) at the female connectors.

c. Remove the nuts (3) and lock washers (4) which mount LL-1 to the control panel.

d. Remove LL-1 (5) from panel (16). For information on indicator cleaning procedures can be found in TO 37C11-1-1 (Refer to Table 1-2). The local Precision Management Equipment Laboratory (PMEL) is responsible for the indicator calibration. Consult with the cognizant PMEL on forwarding an indicator for calibration.

e. Remove the indicator male connectors (6 and 7).

f. Put anti-seize tape on the NPT end of (6 and 7) and install (6 and 7) into the replacement indicator (5).

g. Install (5) into panel (16) and install lockwashers (4) and nuts (3).

CAUTION

Do not pinch or bend tubing for indicators as this will result in restrictive product flow providing an inaccurate indicator reading.

h. Install line tubes (1 and 2).

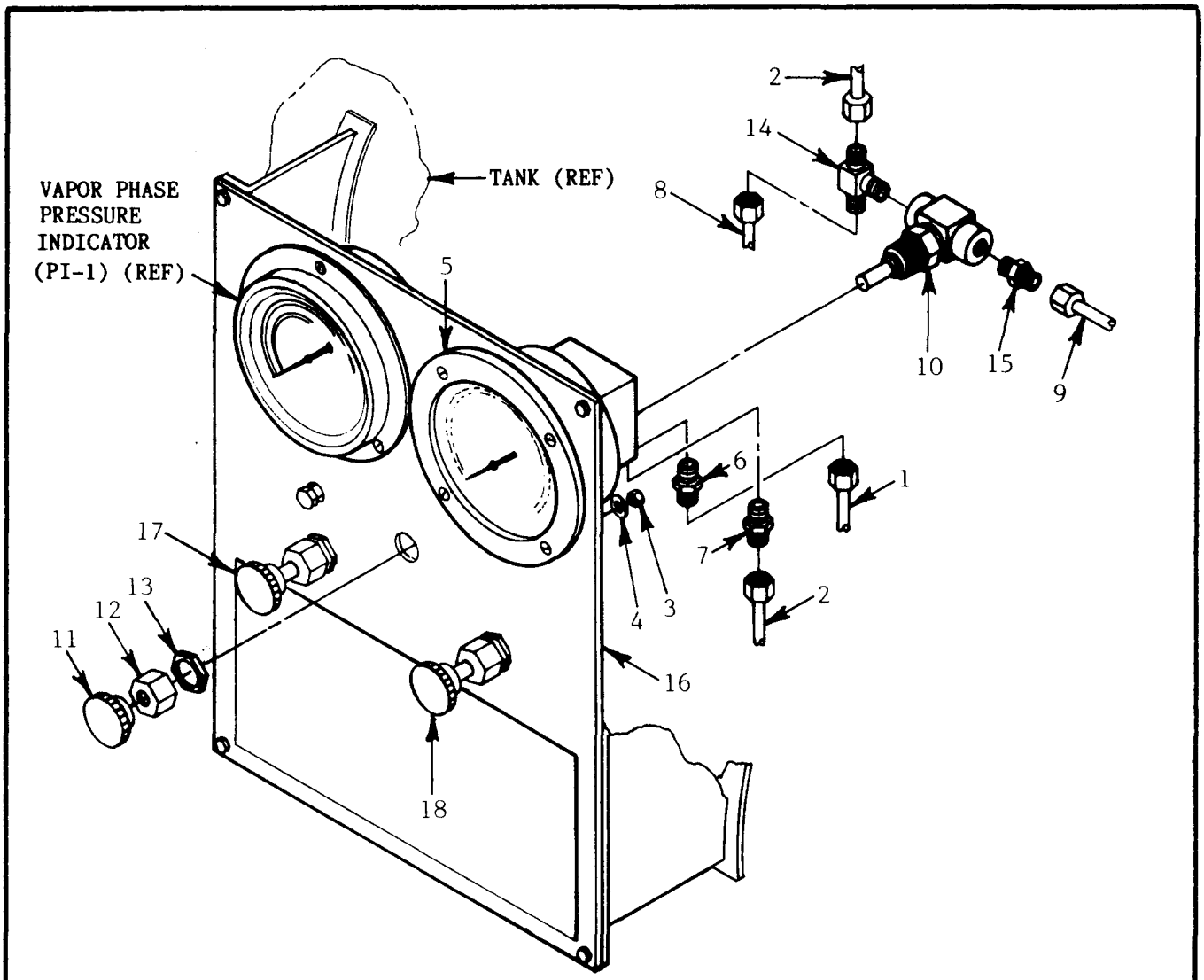
i. Open isolation valves (17 and 18).

j. Leak test the threaded joints.

5-4.2 Level Indicator Equalizer Valve (V-12) (Figure 5-3). Removal and replacement of V-12 is as follows:

a. Close valves (17 and 18).

b. Remove line tubes (2, 8, and 9).



1. Line Tube
2. Line Tube
3. Nut
4. Lock Washer
5. Tank Liquid Level Indicator (LL-1)
6. Indicator Male Connectors
7. Indicator Male Connector
8. Line Tube
9. Line Tube
10. Level Indicator Equalizer Valve (V-12)
11. Knob
12. Packing Nut
13. Panel Nut
14. Tee
15. Fitting
16. Panel
17. Level Indicator Isolation Valve (Vapor V-10)
18. Level Indicator Isolation Valve (Liquid V-11)

Figure 5-3. Control Panel Component Removal and Replacement.

c. Remove knob (11), packing nut (12), panel nut (13), and valve (10).

d. Remove tee (14) and male connector (15).

e. Put anti-seize tape on the NPT end of tee (14) and male connector (15) and install into valve (10).

f. Install (10) in panel (16) and install panel nut (13), packing nut (12), and knob (11).

g. Install line tubes (2, 8, and 9).

h. Open isolation valves (17 and 18).

i. Leak test the threaded joints.

5-5 VACUUM SYSTEM MAINTENANCE.

5-5.1 Tank Efficiency. The efficiency of the Tank depends on the vacuum in the annular space between the inner and outer shells. The vacuum may be lost by leaks, gas diffusion, or contamination. As it is impossible to maintain a perfect vacuum, some loss of the vacuum level may be expected as time passes. It is important to maintain records of the vacuum level of every Tank. A slow deterioration of vacuum as shown in the records will indicate normal loss with passage of time. To correct the loss of vacuum a simple evacuation (pump-out) is required instead of extensive repairs.

5-5.2 Evidence of Vacuum Loss. Outward indications of vacuum loss on the Tank are as follows:

a. A visible and abnormal amount of vapor escaping from the vapor vent line.

b. Severe weight loss while product is in idle storage.

c. High pressure in the inner shell whenever the vapor vent valve (V-8) (Figure 4-1) is closed. This will cause

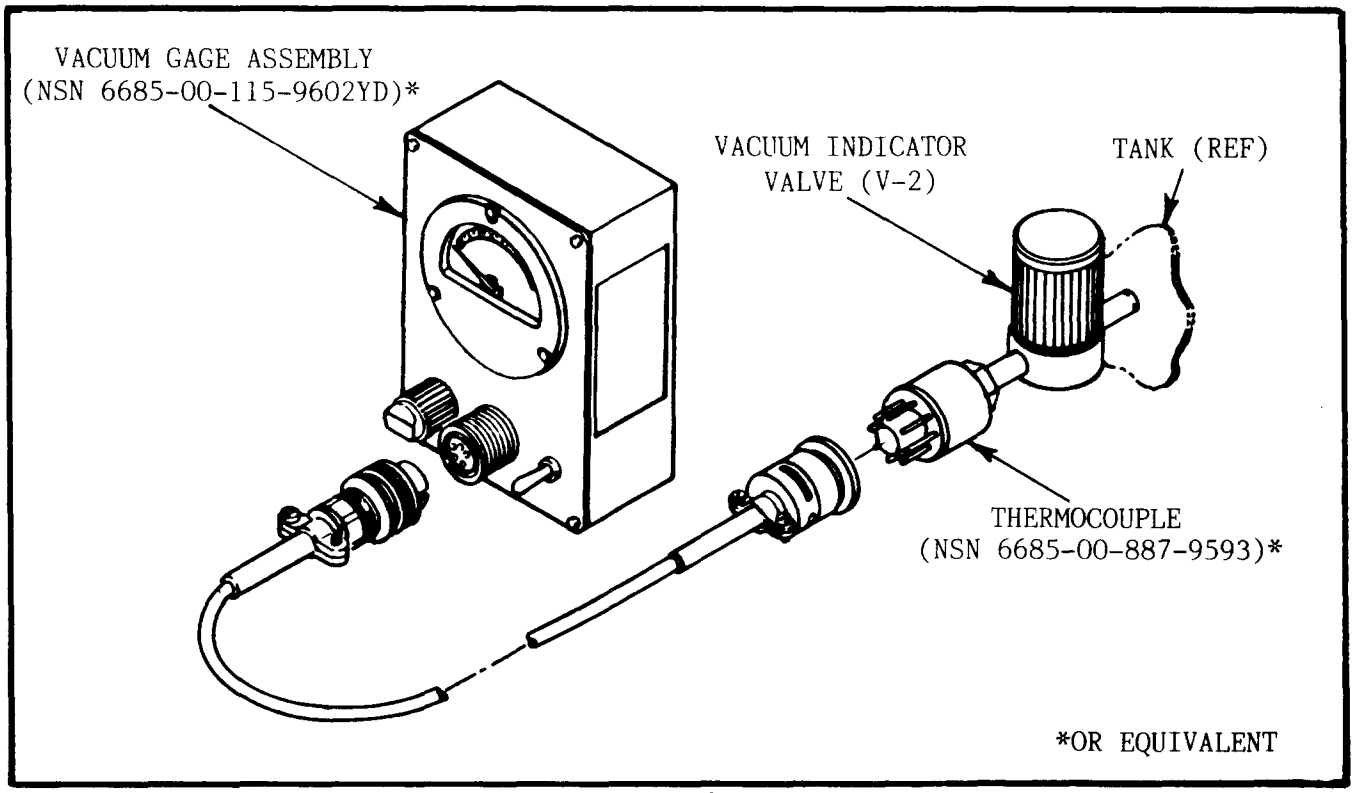


Figure 5-4. Annular Space Efficiency Test.

a constant relieving of the pressure relief valve (RV-3).

d. A cold, sweating outer shell.

e. Failure of a regular efficiency test.

5-5.3 Repair Procedures. Determination of the cause of the loss may be extremely difficult. The tools and equipment for detailed leak detection are not available at the base level. Every attempt must be made to find the cause of the leak as this will determine which agency will be required to make the repairs. (Losses due to leaks or contamination are beyond the capabilities of base level repair.)

a. When the repair requirements have been determined, depot assistance will be requested according to TO 00-25-107.

b. The request for depot assistance will include a description of all deficiencies of the Tank and a detailed repair cost estimate reported on AFTO Form 375. Instructions for preparing the AFTO Form 375 are contained within TO 35-1-24.

5-5.4 Vacuum Efficiency Test Procedure (Figure 5-4). The use of the Dual Efficiency Meter is recommended, if available, in lieu of the portable vacuum gage for determining the efficiency of the Tank vacuum. The vacuum gage is used in the procedures as follows:

NOTE

For basic procedures for the Vacuum Gage or Dual Efficiency Meter refer to Table 1-2.

a. Attach a portable thermocouple (vacuum) gage (Refer to Table 2-1) receptacle to the vacuum sensor as shown in Figure 5-4.

b. Open the vacuum indicator shut-off valve (V-2) and allow the system to stabilize for two (2) minutes before proceeding.

c. Switch the thermocouple gage to ON and read the gage.

NOTE

The annulus vacuum in a cold Tank should be less than 10 microns. If the indication is greater than 35 microns the Tank must be evacuated (Refer to TO 37C2-8-29-3).

d. After the reading has been completed and recorded, close V-2 and set the thermocouple gage switch to OFF.

CAUTION

To avoid vacuum loss make sure V-2 is closed tightly at all times except when taking a reading with a vacuum gage.

e. Disconnect the thermocouple gage receptable from the vacuum sensor.

Table 5-1. Troubleshooting Procedures.

Trouble	Probable Cause	Remedy
a. Low flow rate through service hose.	Low Tank pressure	Raise Tank to 50 psig.
	Clogged filter (F-1).	Remove and replace filter.
	Service valve (V-3) is partially closed.	Open valve fully. Also see g.
	Ice or contaminated product in ports, valves, or hose.	Check for and dispose of ice or contaminated product.
	Fill valve on the receiving tank is partially closed.	Open fill valve on the receiving tank.
b. Low flow rate through fill/ drain hose.	Clogged filter (F-2).	Remove and replace filter.
	Fill/drain valve (V-5) partially closed.	Open valve fully. Also see g.
	Supply valve on the supply tank is partially closed.	Open supply valve on the supply tank.
	Vapor vent valve (V-8) closed.	Open valve.
c. Liquid level gage oscillates: FULL-EMPTY.	Leak in gage line from Tank to gage or an obstruction in the line.	Check for leaks in gage line. Repair or remove obstruction as necessary.
d. Liquid level gage consistently indicates high or low.	One of valves at Tank is closed.	Check valves for proper positions.
	Gage equalizer valve (V-12) in the balance position.	Set equalizer valve to the READ (closed) position.
	Gage needle bent, stuck, or loose.	Tap gage slightly. Inspect needle for bends. Repair or replace as necessary.
	Gage damaged, out of adjustment or calibration.	Replace. Return to depot for calibration.
	Leaking gage line or valve.	Inspect for leaks and repair as appropriate. Also see g.

Table 5-1. Troubleshooting Procedures-Continued.

Trouble	Probable Cause	Remedy
e. Liquid level or Pressure gage not operating.	Ice or foreign material clogging lines or bellows.	Disconnect line. Clean or thaw as necessary.
f. Frozen valve	Moisture in stem packing.	Thaw and dry valve with hot, dry, oil-free, nitrogen gas. Tighten packing nut.
g. Frost on top of valve stem extending to the top.	Loose packing gland nut on valve stem.	Tighten packing gland nut.
h. Valve leaking vapor and liquid.	Foreign material or ice on valve seat. Valve seat worn, broken or missing.	Drain Tank. Disassemble valve and replace seat.
i. Valve fails to pass product or gas.	Defective valve.	Inspect valve. Open and close it several times to check operation. Refer to T.O.37C2-8-29-3. for disassembly, repair, and replacement procedures.
j. Tank will not build or maintain pressure with the pressure build-up valve (V-7) open.	Line to pressure build-up coil clogged. Faulty pressure buildup valve. Relief valve leaking, frozen open, or opening too soon. Rupture disc has burst. Low liquid level. Leaks to atmosphere.	Clear obstruction from line. See f and i. See f and h. Replace rupture disc. Refer to T.O.37C2-8-29-3 Fill Tank. Locate Leaks. Repair if authorized.
k. Excessive Tank pressure.	Malfunction of pressure gage resulting in faulty indication. Over-filling of Tank.	Check pressure gage. Replace it necessary. Drain excess product.

Table 5-1. Troubleshooting Procedures-Continued.

Trouble	Probable Cause	Remedy
k. (Cont'd) Excessive Tank pressure.	Low liquid level with the Tank idle and vapor vent valve (V-8) closed.	Fill Tank.
	Loss of annulus vacuum.	Check vacuum level. Evacuate annulus.
	Pressure buildup valve (V-7) open or leaking.	Check valve for proper closing or leaks.
l. Loss of annulus vacuum.	Normal deterioration of vacuum.	Check vacuum level. Evacuate annulus.
	Leaks to atmosphere.	Check for leaks at rupture disc, outer tank, where piping enters tanks, and vacuum seal-off valve.
	Leaks at thermocouple or vacuum gage valve.	Make sure that valve is closed and threaded connections are sealed. Replace components if necessary. Evacuate per T.O.37C2-8-29-3.
m. Failure to attain vacuum during evacuation.	Incorrect reading of vacuum gage.	Read gage again or open vacuum indicator shut off valve.
	Leaks in vacuum pump hose, or equipment.	Locate and repair leaks.
	Defective gage.	Replace gage with one of known accuracy.
	Undected leak in Tank.	Locate and repair.
	Defective pump.	Repair pump with one of known performance.
	Moisture in pump lubricant.	Drain and replace lubricant.
	Moisture in pump.	Open pump ballast valve.

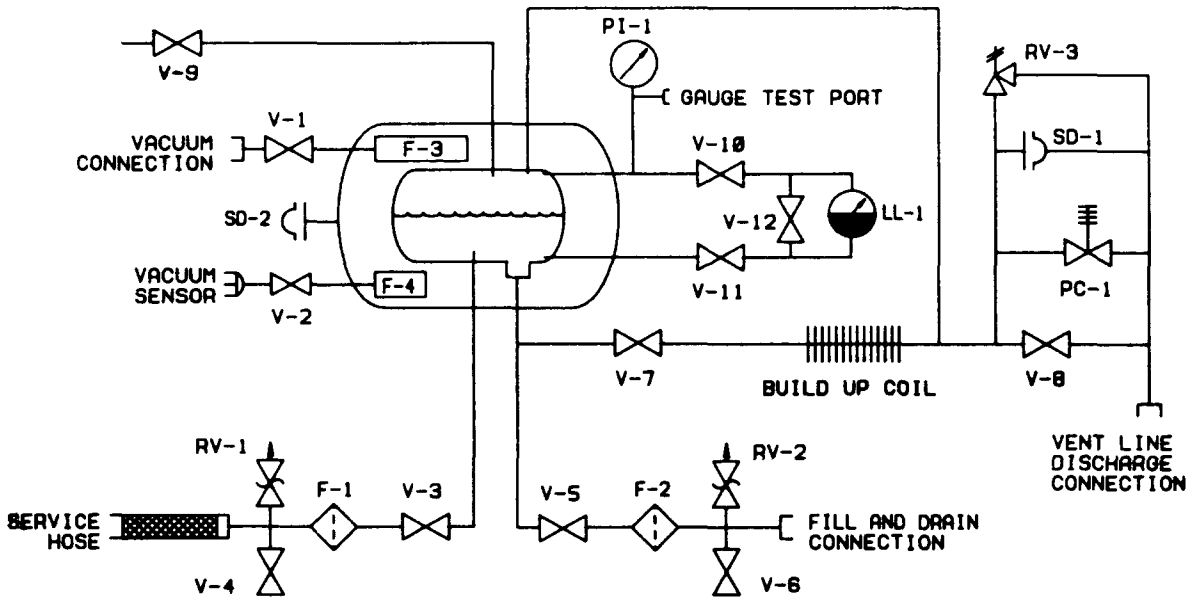
SECTION VI
DIAGRAMS

6-1 FLOW SCHEMATIC DIAGRAM.

6-1.1 Scope. A Flow Schematic Diagram (See Figure 6-1) is included to provide maintenance technicians with a better understanding of the design and function of each component on the Tank.

6-1.2 The diagram will assist maintenance technicians for reference purposes during troubleshooting and maintenance work.

6-1.3 A single diagram covers all of the cryogenic components used on the Tank.



SD-1 INNER SHELL SAFETY HEAD
SD-2 OUTER SHELL SAFETY HEAD
F-1 SERVICING LINE FILTER
F-2 FILL/DRAIN LINE FILTER
F-3 VACUUM FILTER
F-4 VACUUM INDICATOR FILTER
LL-1 TANK LIQUID LEVEL INDICATOR
PI-1 VAPOR PHASE PRESSURE INDICATOR
RV-1 SERVICING LINE PRESSURE RELIEF VALVE
RV-2 FILL/DRAIN LINE PRESSURE RELIEF VALVE
RV-3 INNER SHELL PRESSURE RELIEF VALVE
V-1 VACUUM LINE SHUTOFF VALVE
V-2 VACUUM INDICATOR SHUTOFF VALVE
V-3 SERVICING LINE SHUTOFF VALVE
V-4 SERVICING LINE DRAIN VALVE
V-5 FILL/DRAIN LINE SHUTOFF VALVE
V-6 FILL/DRAIN LINE DRAIN VALVE
V-7 PRESSURE BUILDUP CONTROL VALVE
V-8 VAPOR VENT LINE SHUTOFF VALVE
V-9 FULL TRYCOCK VALVE
V-10 LEVEL INDICATOR ISOLATION VALVE (VAPOR)
V-11 LEVEL INDICATOR ISOLATION VALVE (LIQUID)
V-12 LEVEL INDICATOR EQUALIZER VALVE
PC-1 ADJUSTABLE PRESSURE CONTROL

Figure 6-1. Tank Flow Schematic Diagram.

SECTION VII
ILLUSTRATED PARTS BREAKDOWN

7-1 ILLUSTRATED PARTS BREAKDOWN.

7-1.1 Scope. Refer to T.O.37C2-8-29-4 (Illustrated Parts Breakdown) for a complete listing of parts for the Tank.

SECTION VIII
DIFFERENCE DATA SHEETS

8-1 DIFFERENCE DATA SHEETS.

8-1.1 Scope. No difference data sheets have been issued for this Tank.